



Fourth GAIN World Conference

Paris, France
June 14-15, 2000

GAIN Working Group B (WG B): Analytical Methods and Tools *Activities & Products*

Co-Chairs:

Dr. James T. Luxhøj, Rutgers University

Mr. Matthias Schmidlin, University of Manchester



Outline

- **Charter and Work Plan**
- **Inventory of Methods and Tools**
- **Tool Review Process**
- **Proposed Next Steps**



Purpose

- **To identify tools that can help the aviation community turn their data into valuable information**
 - **Continued improvement in aviation safety will require more extensive use of analytical tools**



WG B Charter

- **Identify and increase awareness of existing methods and tools**
- **Solicit requirements for additional analytical methods and tools from the aviation community**
- **Promote the use of existing methods and tools as well as the development of new ones**

GAIN Steering Committee WG B Charter

*WG B Initial focus:
Flight Safety Offices*

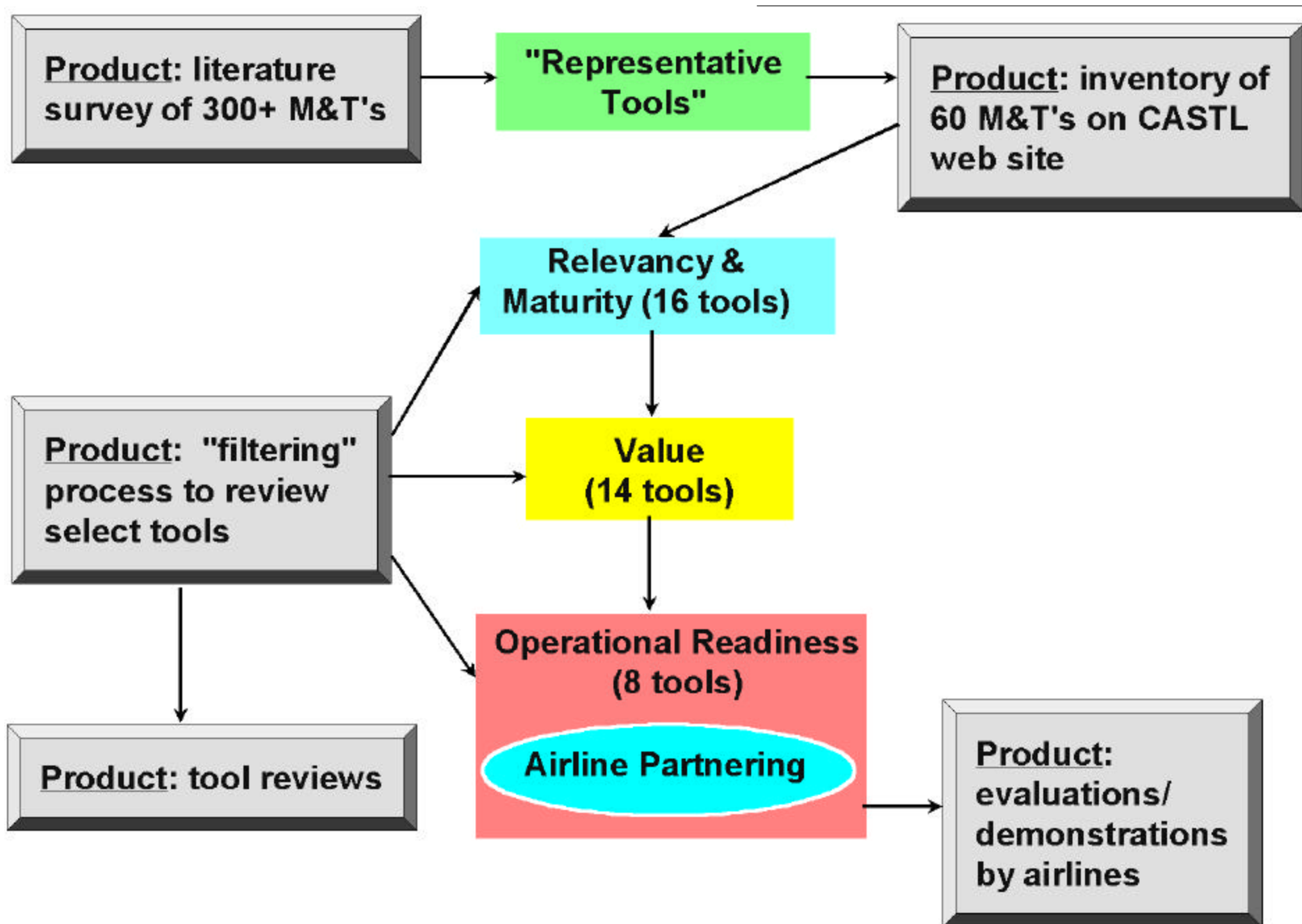
**GAIN WG B:
Analytical Methods
& Tools**

*"Supporting the foundation
of sharing"*

**Surveys:
Needs Assessment**

**9 GAIN Steering Committee
13 Airlines (FSOs)**

**Product: sample of
airline analytical needs
(small, medium, large
airlines)**





WG B Meetings

<u>Date</u>	<u>Location</u>	<u>Hosts</u>
Mar 99	Washington, DC	FAA
Jun 99	Ottawa	Transport Canada
Sep 99	St. Louis, Mo.	TWA
Nov 99	Paris	Air France, BEA, DGAC
Jan 00	Washington, DC	FAA
Mar 00	Montreal	Transport Canada
May 00	Washington, DC	FAA

Participating Organizations



- Abacus Technology Corporation
- Aer Lingus
- Aircraft Engineers International
- Air France
- Algo Plus Consulting
- BEA (France)
- DGAC (France)
- FAA
- ICAO
- Japan Civil Aviation Bureau
- Japanese Assoc. of Air Transport Engineering & Research
- MITRE Corporation
- Oak Ridge National Laboratory
- Rannoch Corporation
- Rutgers University
- Sandia National Laboratories
- TPG America
- Transport Canada
- Transportation Safety Board of Canada
- TWA
- University of Alabama
- University of California at Berkeley
- University of Manchester
- Volpe Transportation Systems Ctr.



Work Plan Activities

- **Conducted a survey of airline flight safety offices to determine their safety analysis needs**
- **Developed a database that lists and briefly describes existing methods and tools potentially useful to the airlines**



Work Plan Activities (cont.)

- **Conducted a 3-stage review of selected tools for small, medium, and large airlines**
 - ***Relevancy and Maturity : Does tool fit airline's needs and is there experience using it?***
 - ***Value : How beneficial is the tool? Does it apply to multiple airlines and/or operational domains and is it affordable?***
 - ***Operational Readiness : Partner with an airline to determine if they can use the tool with a minimum of effort to turn some available input data into a worthwhile/valuable information product.***



WG B Products

- **An inventory of methods and tools potentially useful to airlines on the Prototype Consolidated Aviation Safety Tools and Links (CASTL) Web-Site**
- **A three-stage process for reviewing analytical tools for Relevance & Maturity, Value, and Operational Readiness**
- **On-site evaluation/demonstration of tools with airline partners**



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Inventory of Methods and Tools



Objectives

- **Prepare an inventory of analytical methods and tools (M&Ts) “potentially useful” to Airline Flight Safety Offices**
- **Post inventory on the Prototype Consolidated Aviation Safety Tools and Links (CASTL) Web-Site**



Definitions

Tool: A software-based/computerized application of one or more methods

Method: An analytical approach or process that may or may not be automated



Focusing on Airline Needs: Surveys

- **To improve WG B's understanding of analytical responsibilities, capabilities, and needs of Airline Flight Safety Offices:**
 - **Surveyed 9 GAIN Steering Committee members**
 - **Surveyed 13 airline flight safety offices from around the world (fleets of 11 to 591 aircraft)**



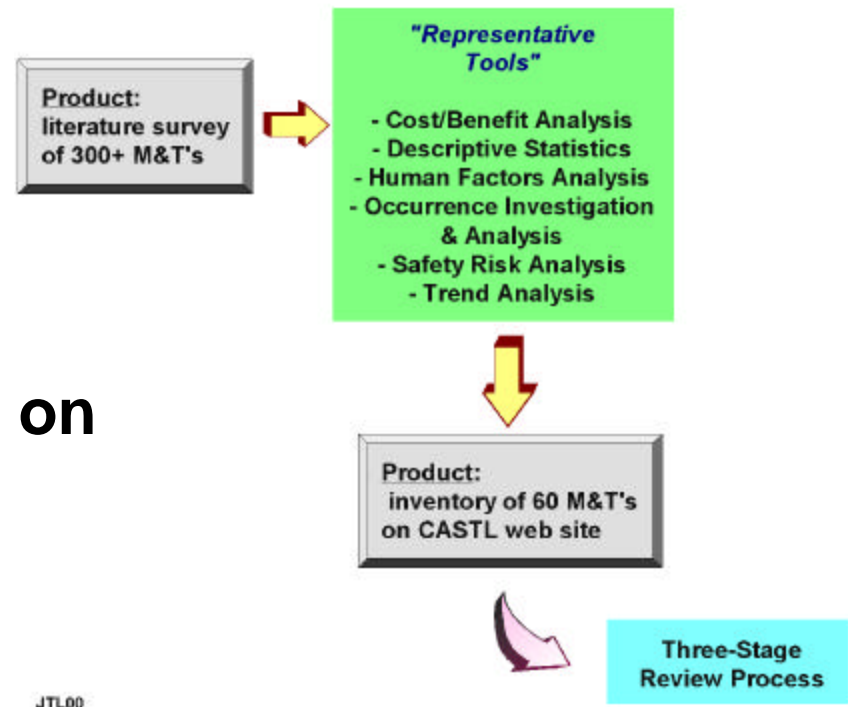
Focusing on Airline Needs: Surveys (cont.)

- **Flight Safety Offices survey results grouped by small, medium, large airlines:**
 - **Types of information collected**
 - **Tools currently in use**
 - **Most useful features of those tools**
 - **Gaps in capabilities of current tools**
 - **Ideas for types of new tools that could be developed**



Focusing on Airline Needs: Refining M&T List

- Identified over 300 analytical M&Ts from various industries (aviation, nuclear power, chemical)
- Identified 90 “potentially useful to airline flight safety offices”
- Created 60 M&T summaries on CASTL web-site under nine functional areas







WG B Inventory of Analytical M&T's (by Functional Area)

<u>Functional Area</u>	<u>Number of Tools</u>
Cost/Benefit Analysis	2
Data Mining/Data Visualization	5
Descriptive Statistics	3
FOQA/Digital Flight Data Analysis	16
Human Factors Analysis	11
Occurrence Investigation & Analysis	4
Operator Accident/Incident Investigation	5
Risk Analysis	10
<u>Trend Analysis</u>	<u>4</u>
Total	60



Consolidated Aviation Safety Tools and Links Web Site

- **CASTL describes a variety of analytical methods and tools that can be used to analyze different types of safety data**
- **Developed to help analyst identify existing computer programs and/or methodologies that can be used to turn aviation safety data into useable information**
- **Prototype site that contains our posted initial list of methods and tool potentially useful to airline flight safety offices**
- **Methods and tools that support other types of aviation safety analysis could be added as CASTL is expanded**



CASTL

Consolidated Aviation Safety Tools & Links

CASTL is a prototype site developed under the Global Aviation Information Network (GAIN) program to facilitate the use of existing aviation safety information. The site provides links to data and information from around the world and describes a variety of analytical methods and tools that can be used to analyze different types of safety data.

Browse

[Data/Information](#)

Browse links to aviation safety data/information according to categories.

[Methods & Tools](#)

Browse links to methods/tools related to safety analysis according to categories.

Search

[Data by Keyword](#)

Search links to sources of aviation safety data by pre-defined keywords.

[By Full Text](#)

Search full text of designated web sites.

User Feedback

[Send Comments](#)

Provide your comments to help improve this prototype site.

Nominate

[New Source](#)

Procedure for suggesting a new link / site / contact for data or methods & tools.

About

[GAIN](#)



Scope and objectives of the GAIN project.


[This Site](#)

Statement of Purpose for this Website.

*CASTL version 1.2
April 21, 2000*

*Best Viewed in
Netscape 4.X and IE 4.X*





CASTL

Analytical Methods and Tools

Browse

[Data/Information](#)

[Methods & Tools](#)

Search

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User Feedback

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[New Source](#)










About

[GAIN](#)


[This Site](#)

[I Cost/Benefit Analysis](#) | [I Data Mining/Data Visualization](#) | [I Descriptive Statistics](#) | [I FOQA/Digital Flight Data Analysis](#) | [I Human Factor Analysis](#) | [I Occurrence Investigation and Analysis](#) | [I Operator Accident/Incident Reporting Systems](#) | [I Risk Analysis](#) | [I Trend Analysis](#) |

This initial list of methods and tools represents some that are potentially useful to airline flight safety offices. Methods and tools that support other types of aviation safety analysis could be added as CASTL is expanded.

- [Cost/Benefit Analysis](#) 
- [Data Mining/Data Visualization](#) 
- [Descriptive Statistics](#) 
- [FOQA/Digital Flight Data Analysis](#) 
- [Human Factor Analysis](#) 
- [Occurrence Investigation and Analysis](#) 
- [Operator Accident/Incident Reporting Systems](#) 
- [Risk Analysis](#) 
- [Trend Analysis](#) 

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Browse

- [Data/Information](#)
- [Methods & Tools](#)

Search

- [Data by Keyword](#)
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User Feedback

- [Send Comments](#)

Nominate

- [New Source](#)

About

- [GAIN](#)
- [This Site](#)

- [Cost/Benefit Analysis](#)
- [Data Mining/Data Visualization](#)
 - [Aerospace Data Miner \(ADAM\)](#)

Purpose:To develop an easy to use domain specific software system that integrates data mining and monitoring techniques to support maintenance and operation of commercial aircraft.
 - [Information Mining Performance Attainment Control Technique \(IMPACT\)](#)



Purpose:To provide individual decision-makers within the traffic and aviation safety communities direct access to accident and incident information.
 - [Integrated Diagnostic System \(IDS\)](#)


Purpose:To develop a real-time remote monitoring system that focuses on troubleshooting procedures during turn arounds.
 - [MITRE Aviation Safety Tool \(MAST\)](#)

Purpose:To provide in a single tool capabilities for gathering, querying and analyzing aviation incident reports.
 - [Spotfire Analysis Tools](#)

Purpose:Create software solutions that empower scientists and engineers-and their enterprises-to make decisions that get products to the market first. Spotfire solutions combine data associated with ingredients, formulations and properties with knowledge of process and performance to optimize results and conduct trade-off analysis.
- [Descriptive Statistics](#)
- [FOQA/Digital Flight Data Analysis](#)
- [Human Factor Analysis](#)
- [Occurrence Investigation and Analysis](#)
- [Operator Accident/Incident Reporting Systems](#)
- [Risk Analysis](#)
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CASTL

Analytical Methods and Tools

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Spotfire Analysis Tools


Title: Spotfire Analysis Tools

Information Source: Spotfire web site
<http://www.spotfire.com>

Purpose: Create software solutions that empower scientists and engineers-and their enterprises-to make decisions that get products to the market first. Spotfire solutions combine data associated with ingredients, formulations and properties with knowledge of process and performance to optimize results and conduct trade-off analysis.

Description: Process Engineers continue to search and mine databases of quality information looking for trends and patterns associated with product defects that may stem from manufacturing processes, materials, suppliers, usage and other variables. Spotfire solutions help sort through this information and provide feedback that can be used in continuous process improvement. At the departmental level, Spotfire products can help extract greater value from investments that have been made in data generation. Research managers can go beyond making better use of data, to improving, fundamentally, the discovery process itself. It allows the construction of specific solutions that reflect the discovery process while inheriting the ease-of-use benefits of the standard products. Spotfire Pro, the flagship product, reads large amounts of multi-variable data originating from disparate data sources and automatically generating intelligent, interactive query devices for rapid identification of trends, anomalies, outliers, and patterns.

Point of Contact: Spotfire, Inc., 60 Hampshire Street, Cambridge, MA 02139,



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CASTL

Nomination Process

Nominate an analytical method or tool to be added to CASTL

To identify additional methods and tools that can be used to transform aviation safety data into useable information, please fill out this form.

Hold down CTRL key for selecting multiple CATEGORIES

CATEGORY:

Cost/Benefit Analysis

Data Mining/Data Visualization

Descriptive Statistics

METHOD/TOOL NAME:

SOURCE OF INFORMATION ABOUT THIS METHOD/TOOL:

Please cite one or more reference materials and/or web sites/URLs.

METHOD ☒


or

TOOL ☐

(An 'analytical method' is defined to mean a process or technique for analyzing data/information relating to flight safety, ground safety, maintenance, air traffic control issues, or weather.)

(An 'analytical tool' is defined to mean a computerized version or application of an analytical method described above.)

PURPOSE:



Browse

[Data/Information](#)

[Methods & Tools](#)

Search

[Data by Keyword](#)

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Nominate

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INFORMATION ABOUT THIS METHOD/TOOL:

METHOD ☒

or

TOOL ☐

PURPOSE:

DESCRIPTION:

POINT OF CONTACT
(for example,
tool developer):

Please include name, organization, phone number, and e-mail address, if available.

Nominator's Contact Information (optional)

EMAIL:

SUBMIT INFORMATION

Clear Form

[Home](#) | [Top page](#)



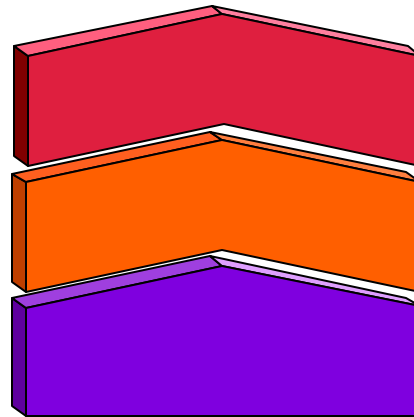
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Tool Review Process



Objectives

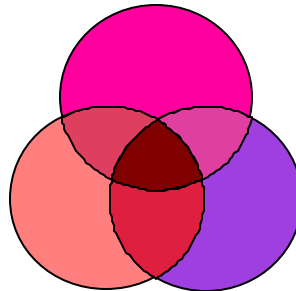
- Find some “good” tools for aviation safety analysis
- Develop a “process” for reviewing tools using specific criteria





Tool Review Process

- WG B followed a structured “**filtering**” process to initially “highlight” some helpful tools to airline flight safety offices



- Selected some **representative** examples from functional areas in inventory to inform the aviation community on the types of analyses that are possible.



Caveats

- **WG B selected tools only (not methods) for the reviews**
- **We did not attempt a comparative analysis of all tools within each functional area**
 - We selected some **good** tools but not necessarily the **best** ones



Caveats

- **WG B is not reviewing flight data analysis tools or tools associated with safety reporting systems that airlines are currently using**
- **We considered small, medium, and large airline applications in our deliberations**



Three-Stage Review of Analytical Tools

Stage 1: Relevance & Maturity (R&M)

- ***Relevance:*** *Does tool meet needs of an airline flight safety office for analysis of safety data/information?*
- ***Maturity:*** *What is the airline or other industry experience using the tool? Is it commercially available or still in development?*



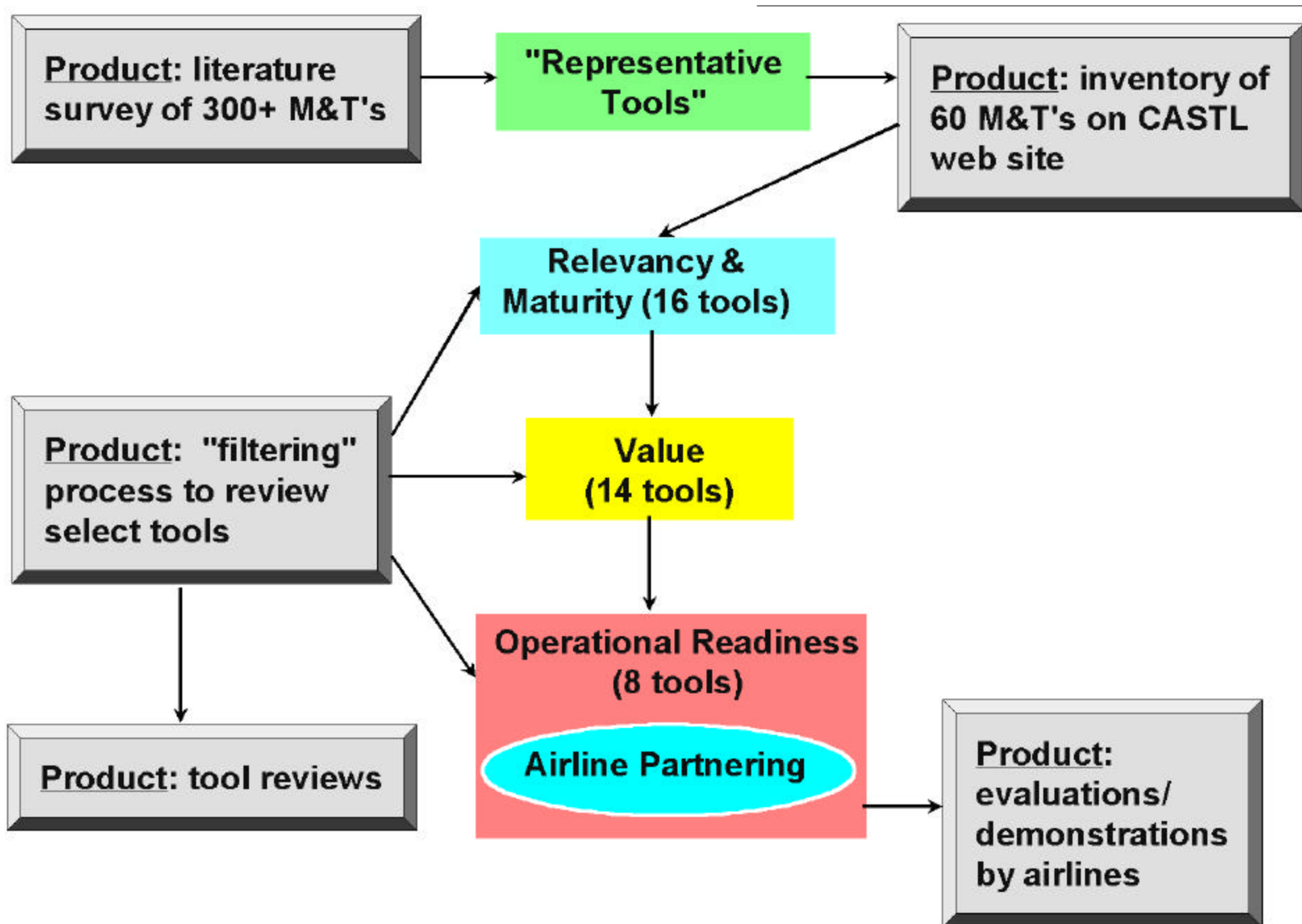
Three-Stage Review of Analytical Tools

Stage 2: Value

How beneficial is the tool? Does it apply to multiple airlines and operational domains and is it affordable (considering installation, training, and operating costs)?

Stage 3: Operational Readiness (OR)

Partner with an airline to determine if they can use the tool with a minimum of effort to turn some available input data into a worthwhile/valuable information product.





Tools in R&M Review

- **Operator Accident/Incident Investigation**
No tools reviewed in 3-stage process
- **Cost-Benefit Analysis**
Boeing Digital Technologies Cost Model
Airbus Service Bulletin Cost Benefit Model
- **Data Mining/Data Visualization**
IMPACT
Spotfire
- **Descriptive Statistics**
Microsoft Excel
- **FOQA/Digital Flight Data Analysis**
No tools reviewed in 3-stage process
- **Human Factors Analysis**
Aircrew Incident Reporting System (AIRS)
HF Analysis & Classification System (HFACS)
Procedural Event Analysis Tool (PEAT)
Computer-Assisted Debriefing System
- **Occurrence Investigation and Analysis**
TapRoot
- **Risk Analysis**
____ Flight Operations Risk Assessment System (FORAS)
@Risk
Fault Tree Analysis
Event Tree Analysis
- **Trending Analysis**
Statgraphics Plus
Characterization/Trend/Threshold Analysis



Review Process

- **WG B members volunteered to review tools by functional areas**
- **Primary/secondary reviewers identified**
- **“Scorecards”, for internal use only, were developed and used to facilitate assessments**
- **Sub-group met to ensure consistency among reviewers**



R&M Criteria

- **Relevancy**
 - Applicability to Flight Safety Office
 - Tool Purpose
- **Maturity**
 - # of Airline Users & Usage Outside Airlines
 - Analytical Foundation
 - Documentation
 - Vendor Support
 - Verification & Validation



Tools in Value Review

- **Operator Accident/Incident Investigation**
No tools reviewed in 3-stage process
- **Cost-Benefit Analysis**
Boeing Digital Technologies Cost Model
Airbus Service Bulletin Cost Benefit Model
- **Data Mining/Data Visualization**
Spotfire
- **Descriptive Statistics**
Microsoft Excel
- **FOQA/Digital Flight Data Analysis**
No tools reviewed in 3-stage process
- **Human Factors Analysis**
Aircrew Incident Reporting System (AIRS)
HF Analysis & Classification System (HFACS)
Procedural Event Analysis Tool (PEAT)
- **Occurrence Investigation and Analysis**
TapRoot
- **Risk Analysis**
@Risk
Fault Tree+ (fault tree & event tree modules)
FaultrEase
SAPHIRE
- **Trending Analysis**
Statgraphics Plus



Value Criteria

- **Potential Benefits**
 - Helps identify unknown hazards
 - Supports safety monitoring
 - Supports prioritization of resources
 - Helps provide operational improvements
- **Versatility**
 - Useful to airlines of many sizes and types of operations
 - Useful for analysis of different kinds of safety data
- **Cost**
 - Direct - purchase price
 - Indirect- installation, operation, maintenance & training



Tools in OR Review

- **Accident/Incident Reporting Systems**
No tools reviewed in 3-stage process
- **Cost-Benefit Analysis**
Boeing Digital Technologies Cost Model
Airbus Service Bulletin Cost Benefit Model
- **Data Mining/Data Visualization**
SPOTFIRE
- **Descriptive Statistics**
Microsoft Excel
- **Flight Data Monitoring/FOQA Analysis**
No tools reviewed in 3-stage process
- **Human Factors Analysis**
Aircrew Incident Reporting System (AIRS)
Procedural Event Analysis Tool (PEAT)
- **Occurrence Investigation and Analysis**
None
- **Safety Risk Analysis**
SAPHIRE
- **Trending Analysis**
Statgraphics Plus



OR Criteria

- **Usefulness**
 - How helpful is the tool to an airline flight safety office? That is, is there a good match among:
 - Available input data
 - Capabilities/characteristics of the tool
 - Airline's higher-level information needs
- **Usability**
 - How easy is the tool to use in terms of set-up, applying input data, generating results, and disseminating those results?



Two Approaches for OR Review

- **New Installation**
 - **Used if WG B has introduced tool to Airline Flight Safety Office that has not used it before**
 - **Conducted phased approach**
 - **Phase I** is pre-conference, less detailed; document initial impressions
 - **Phase II** is post-conference, more experience with tool, more detailed; complete full OR scorecard



Two Approaches for OR Review (cont.)

- **Existing Installation**
 - **Used for tool that is already being used within the partner airline**
 - **Airline will share thoughts on tool regarding:**
 - **Successes with tool**
 - **Insights gained about tool**
 - **Challenges of implementing tool**
 - **Features or drawbacks of tool**



Tools In OR Review

- **New Installations**

<u>Tool</u>	<u>Functional Area</u>	<u>Partner Airline</u>
SAPHIRE	Risk Analysis	Delta
Spotfire	Data Mining/ Data Visualization	Delta
Statgraphics	Trending, Descriptive Statistics	Northwest



Tools In OR Review (cont.)

- Existing Installations

<u>Tool</u>	<u>Functional Area</u>	<u>Partner Airline</u>
AIRS	Human Factors	TAM Brazilian
Airbus CBA Tool	Cost/Benefit	Air France
Boeing CBA Tool	Cost/Benefit	TWA
Microsoft Access	Safety Database	Airborne Express
PEAT	Human Factors	Continental



Tools in OR Review (cont.)

- **SAPHIRE** - used to construct and analyze event trees to obtain measures of system unreliability. Some features of SAPHIRE include:
 - Structured modeling of events using uncertainty techniques
 - Analysis, database, and reporting modules work as a single integrated software tool
- **Spotfire** - A data visualization tool with capability to:
 - Read large amounts of multi-variable data originating from disparate data sources
 - Automatically generate trends and identify anomalies, outliers and patterns.



Tools in OR Review (cont.)

- **Statgraphics** - A statistical analysis package that provides:
 - Over 200 statistical analyses/graphics choices
 - Screens to guide the user through the various analyses
- **AIRS** - A confidential human factors reporting system offered primarily to Airbus customers:
 - Provides airlines the necessary tools to set up an in-house human performance system
 - Main categories are crew behavior and contributory factors



Tools in OR Review (cont.)

- **Microsoft Access** - Low cost, universal database package useful for identifying/recording safety data (e.g., incident data). This package also facilitates:
 - Analysis capabilities
 - Event classification schemes
- **PEAT** - Designed by Boeing to help identify the key underlying cognitive factors that contribute to procedural non-compliance:
 - Focuses on why and how the event occurred
 - Requires airline to adopt a non-jeopardy approach to incident investigation



Tools in OR Review (cont.)

- **Airbus CBA Tool** - Assists airline engineering departments in the selection and prioritization of optional modifications for their fleet.
- **Boeing CBA Tool** - Quantifies the financial impact of delays and cancellations due to airline incidents.



Proposed Next Steps



Proposed Next Steps

High Priority

- **Continue with the Phase II Operational Readiness reviews of analytical tools (post-conference)**
- **Identify funding options to conduct tool reviews and identify need for new tools (Government and industry)**



Proposed Next Steps

High Priority

- **Partner with an airline to apply a textual data mining tool to narrative reports (e.g., pilot ASAP reports)**
- **Team with WG A (Operator Safety Practices) to conduct regional workshops to inform local airlines of WG B's activities and products**



Proposed Next Steps

Medium Priority

- **Publicize WG B products and progress through a quarterly newsletter or status report via e-mail.**
- **Create a web forum for Flight Safety Officers to exchange safety analysis tips.**



Proposed Next Steps

Medium Priority

- **Form a WG B “Advisory Committee” in which a few airline Flight Safety Officers could provide high-level guidance to WG B.**
- **Create a suite of analytical tools (i.e, a “turnkey” analysis toolkit) specifically geared to smaller airlines.**



**Most important - we want your
ideas and your participation!**





WG B Implementation Workshop

**Join WG B for workshop on
“Analytical Methods and Tools”
Tomorrow, June 15**

Session 1: 10:30 am

Session 2: 11:30 am